TITLE

# Lithium Ion Batteries

## Cross Reference

This application claims priority to a Chinese patent application entitled "Lithium Ion Batteries" filed on June 13, 2003, having a Chinese Patent Application No. 03247291.9; this Chinese application is incorporated herein by reference.

## Field of Invention

The present invention relates to a type of battery, and, in particular, a type of rechargeable lithium ion battery suitable for use in mobile phones, PDAs, and mobile equipment.

## Background

Lithium ion battery is a new type of high capacity, high output, safe, environmentally friendly, and non-pollutive rechargeable battery. It has wide applications for use in equipments such as mobile phones, laptop computers, PDAs, etc. and has become the standard accessory for these types of equipments.

Lithium ion battery typically is comprised of a battery core, a battery protective circuit, a plastic external body shell, etc. The battery protective circuit is placed within the body shell between the battery core and the shell. The plastic external body shell is used to secure the corresponding position between the battery core and the battery protective circuit and to protect the battery protective circuit. Within the battery core,

there are positive and negative electrodes, one or more separators, and electrolyte. The entire battery core is encased in a metal external casing. On the exterior of the battery core, there are positive and negative terminals connecting to the interior positive and negative electrode of the battery core. The positive and negative terminals are first connected to the battery protective circuit. Then through the contact points of the battery protective circuit, it is connected to the body or the charger of the mobile phone, laptop computer, PDA, etc. to carry the load of such devices. This type of battery needs a separately manufactured plastic body shell for encasing the battery core, and the cost is higher for the manufacturing for such plastic body shell. Also, it is more complicated and less convenient in the assembling of the battery core into a battery product.

In order to solve the above problem, one newer type of lithium ion batteries use a plastic external shell, where a cover is injection molded on to each of the top and bottom end of the battery core. The battery protective circuit is glued between the cover and the battery core. On top of the cover, there are openings and holes provided to allow the contact plates of the battery be exposed to the outside world, where the contact plates are connected to the battery protective circuit and the positive and negative electrodes. The disadvantage of this method is that the injection molding process is more complicated, the cost is higher, and the adhesion between the cover and the battery core is low as well.

In order to increase the hold between the cover and the battery core, Japanese company, Matsushita, first welds a nail to each of the two ends of the shell body. Then, it uses an injection molding method to manufacture the cover that is secured to the battery core. This method to a certain degree increased the hold between the cover and the

battery core. However, the manufacturing process is more complex and it still does not resolve the cost issue.

The disadvantages of the prior art illustrate the need for a battery structure that is conducive to the manufacturing and assembling process and yet it is low in cost.

## Summary

An object of the present invention is to provide a battery structure having a strong hold between the battery cover and the battery core.

Another object of the present invention is to provide a battery structure having a simple manufacturing and assembling process and low overall cost.

Briefly, a rechargeable battery is disclosed, comprising: a cover having an elongated rectangular shape with two opposite ends, said cover having a plurality of contact openings, a plurality of test openings, a screw opening on each of said two ends, and a position notch on each of said two ends; wherein said cover is made by injection molding using plastic or rubber; a battery protective circuit providing functions preventing overcharging, excessive-discharge and excessive current; a battery core having an elongated rectangular shape substantially matching the shape of said cover, wherein said battery core having a metal outer shell, and a top-side plate that is welded to the outer shell of said battery core to seal said battery core; wherein said top-side plate having a thickness of 0.3 mm – 0.6 mm and having disposed thereon a negative terminal, a release valve, a fill hole, position holes and screw holes; and a structural support placed between said battery core and said cover, said structural support and said cover encasing said battery protective circuit; wherein said cover covering said battery protective circuit,

and said cover and said battery protective circuit being secured on to said battery core to form an integrated battery; and wherein said battery core having positive and negative terminals connected to said battery protective circuit and, through said battery protective circuits, to contact plates exposed through said cover.

An advantage of the present invention is that it provides a battery structure having a strong hold between the battery cover and the battery core.

Another advantage of the present invention is that it provides a battery structure having a simple manufacturing and assembling process and low overall cost.

## Brief Description of the Drawings

The combination of figures and embodiments further describe the present invention:

Figure 1 is an external view of the complete lithium ion battery.

Figure 2 is an external view of the battery core of the lithium ion battery.

Figure 3 is a break out of an embodiment of the structure of the battery cover and the battery core.

Figure 4 is a break out of another embodiment of the structure of the battery cover and the battery core, showing the structural support piece.

Figures 5a and 5b illustrate the two sides of the printed-circuit-board of an embodiment of the present invention.

Figure 6 illustrates another embodiment of the present invention where the cover and the structural support is one unit.

Figure 7 illustrates still another embodiment of the present invention where the cover and the structural support is one unit.

## Detailed Description of the Preferred Embodiments

In a presently preferred embodiment of the present invention, a type of battery structure, having a battery core, battery protective circuit and a cover, is disclosed. Referring to Fig. 1, on the cover 1, there are various openings and holes, and the cover 1 is manufactured as a separate unit. The cover 1 is an elongated, rectangular-shaped structure. In this structure, the cover 1 is manufactured to have a certain height in order to provide a safe distance between the opening at the top of the battery core 6 and the cover 1. There is a screw opening 5 on each of the two ends of the cover 1, and there is a screw inserted through each of the screw opening 5 on top of the cover 1 and the screws are fastened to a screw hole on top of the battery core 6 in order to secure the cover 1 to the battery core 6. There are also a number of contact openings 10 and a number of test openings 11.

As an improvement over the prior art, the cover 1 is first injection molded using rubber or plastic. There can be a top cover 1 and a bottom plate 7 in order to provide for the necessary spacing support to the final battery product. A battery protective circuit can be placed between the top cover 1 and the battery core 6.

Referring to Fig. 2, an embodiment of the body of the battery core 6 is illustrated. Here, the battery core is a rectangular-shaped with long oval top and bottom ends. The sides of the battery core are round. Inside the battery core 6, there are positive and negative electrodes, positive and negative terminals, insulation for separating the positive

and negative electrodes, and electrolyte. The battery core 6 is sealed and encased in a metal shell, the metal of which can be aluminum, stainless steel, electro-plated nickel, etc. On the top of the battery core 6, there is a top-side plate 14 having the same material as the metal shell of the battery core 6. After inserting the electrodes and the various inside components into the battery core, the top-side plate is welded to the metal shell body of the battery core 6. On the top-side plate 14, there is a negative terminal 13 connected to the negative electrode inside of the battery core 6. The positive electrode of the battery core 6 is connected to the metal shell of the battery core 6 and the top-side plate 14. A metal plate is connected to the top-side plate 14 to form the positive terminal. There is an insulation barrier between the negative terminal 13 and the top-side plate 14 connecting to the positive terminal. On the top-side plate 14, there is also a release valve 12 and a fill hole 15. The release valve 12 automatically releases excessive internal pressure built-up in order to prevent battery explosion. The fill hole 15 is used, after the battery core 6 is completely assembled, to fill electrolyte into the interior of the battery core 6. The fill hole 15 is sealed after filling the electrolyte, and it can be sealed by welding a metal plate over it. There is also a screw hole 17 on each side of the top-side plate 14 for receiving screws to secure the cover to the top-side plate 14. There is also a position hole 18 on each end of the top-side plate 14. These position holes allow the cover to be quickly and accurately positioned on to the top-side plate 14, thus facilitating the manufacturing and assembling process.

Referring to Fig. 3, the battery protective circuit 2 and a safety unit 4 are placed between cover 1 and the battery core 6. The battery protective circuit is designed for ease of manufacturing and assembling as well. The battery protective circuit 2 provides

overcharging, excessive-discharging, and excessive current functions, preventing the battery from overcharging, excessive-discharging, and excessive current during charging, and other conditions that may damage the battery. The battery protective circuit is on a PCB. On one side of said battery protective circuit there are contact points 22 for contacting said battery and test points 20 for testing said battery. The safety unit 4 provides a temperature protection function, among other safety related functions. If the temperature rises excessively high during charging, safety unit 4 will automatically cut off the source to protect the battery. The negative terminal 13 (see Fig. 2), which is connected to the negative electrodes of the battery core 6, is first connected to the safety unit 4, and through the safety unit 4 is connected to the battery protective circuit 2. The positive terminal, which is connected to the top-side plate 14 on top of the battery core 6, through the connecting unit 9 connects directly to the battery protective circuit 2. The battery protective circuit 2 interacts, for example, within the body of mobile phones, laptop computers, PDAs, etc. or with the respective charging unit.

The battery protective circuit 2 connects to positive and negative contact plates and it provides contact points for identifying the battery type. On the cover 1, there are square openings 10 for allowing exterior contact to the contact plates of the battery protective circuit board 2, and circular openings 11 for allowing testing of the battery and the battery protective circuit 2. The positive and negative electrodes of the battery core 6, through each respective terminal, safety unit 4, and the battery protective circuit 2, and through the positive and negative contact plates of the battery protective circuit, connect with the load or charger, in order to provide power to the device or equipment or to receive charge to the battery.

The top-side plate 14 on top of the battery core 6 has a sufficient thickness to ensure that there is a safe distance between the openings and the battery core 6. The outer shell of the battery core 6 starts as an enclosure with one open end. As described above, the top-side plate 14 serves as the cover to the open end of the outer shell of the battery core 6 and the top-side plate 14 is welded to the outer shell of the battery core 6 to seal the battery core 6 and to ensure that the battery core does not leak during usage. After much empirical studies and research, when using aluminum as the common material for the outer shell of the battery, the top-side plate 14 thickness should be over 0.3 mm, preferably between 0.3 to 0.6 mm. If it is less than 0.3 mm, then it is easier for leakage to occur. If it is greater than 0.6 mm, it would result in waste and it would not be necessary.

A screw is inserted through a screw opening on each side of the cover and screwed into the screw holes (Fig. 2, 17) on the battery core 6 in order to secure the cover 1 to the battery core 6. A piece of insulation paper is placed between the battery core 6 and the battery protective circuit 2 to insulate them. The cover 1 is first made by injection molding using rubber or plastic. Due to the low cost of rubber or plastic as the raw material and that the injection molding process is also a simple manufacturing method, the overall manufacturing and assembling process is simplified and the overall cost is lowered.

The outer shell of the battery core 6 is typically made from the metal aluminum. Aluminum is typically soft, thus the openings on the outer shell of the battery core 6 need not have threads in the screw holes. When the screws are secured into these holes on the outer shell of the battery core 6, it will naturally form the threads in the openings.

Obviously, threads can also be formed in the holes on the outer shell of the battery core 6 as well; if so, a harder material can be used for the top-side plate of the outer shell of the battery core 6, such as stainless steel. This method increases the hold between the cover 1 and the battery core 6.

In order to increase the hold and the seal between the cover 1 and the battery core 6, adhesive sealer can be applied to the screws and between the battery core 6 and the cover 1. By using the screws in combination with the adhesive sealer, the cover 1 and the battery core 6 can be tightly fastened. On the bottom of the battery core 6, there is also a bottom plate 7. The bottom plate 7 is also made by injection molding using rubber or plastic, and is glued on to the battery core 6 by adhesive sealer.

Furthermore, there can be placement holes (Fig. 2, 18) near the opening on the top of the battery core. Small position notches on the cover at positions corresponding to the position holes (Fig. 2, 18) on the top of the battery core 6.

Figure 4 shows an illustration of another embodiment of the present invention of a lithium ion battery. It differs from the first embodiment in several respects. The top-end cover is formed by a top cover 1 and a structural support 3. The structural support 3 supports the battery protective circuit 2, where the battery protective circuit 2 is placed between the top cover 1 and the structural support 3. The structural support 3 is also separately made by injection molding using rubber or plastic, and glued to the battery core 6 using adhesive sealer. The protective unit 4 is placed under the support 3. The support 3 provides protection and insulation functions to the battery protective circuit 2, ensuring the safety of the battery protective circuit 2 and the battery. Because of the existence of the support 3, this embodiment does not require insulation paper 8.

When a top cover 1 and structural support 3 are used and the battery protective circuit is placed between the top cover 1 and structural support 3, this combination can be used to support and segregate the battery protective circuit 2 and used to define the position of the battery protective circuit 2 relative to the battery core 6.

In these embodiments, in the manufacturing and assembling process, in order to quickly and accurately position cover 1 (and/or structural support 3) on the battery core 6, position holes are provided near the openings on the top of the battery core 6. On the bottom of cover 1 (and/or structural support 3) and on the corresponding positions of the position holes on top of the battery core 6, small position notches are provided on the bottom of cover 1 (and/or structural support 3).

In yet another embodiment of the present invention, the battery protective circuit 2 is specifically designed to provide ease in the assembling of the battery and yet to ensure solid contact between the battery core 6 and the battery protective circuit 2. Referring to Fig. 5a, the battery protective circuit 2 is on a printed-circuit-board ("PCB") 30, and on the PCB 30 there is a first contact structure 32 providing contact between the PCB and the negative terminal of the battery core 6. There is also a second contact structure 34 providing contact between the PCB and the protective unit 4. The contact structures protrude away from the PCB and into the respective openings provided on the structural support 3. The contact structures 32, 34 can be formed using a conductive material and can be spring loaded. The contact structures 32, 34 can be mounted on the PCB using a variety of methods. Fig. 5b illustrates the other side of the PCB 30. Here, there are a plurality of test points 20 and a plurality of contact points 22 etched on the

PCB. There are of course a number of other components on the PCB to carry out the functions provided by the PCB.

Still in yet another embodiment of the present invention, Fig. 6 illustrates a bottom view of a one-piece unit of the cover 40 and the structural support 42. The cover 40 and the structural support 42 are injection molded as one unit, further simplifying the assembling process. Here, the battery protective circuit (as described above) is inserted into the bottom of the cover 40 and the structural support 42 is then snapped into place. The structural support 42 is connected to the cover 40 via a thin plastic hinge 44; all of which are injection molded as a single piece. The entire structure is again secured to the top of the battery core via methods described above.

In yet still another embodiment of the present invention, Fig. 7 illustrates an angled, top view of a one piece cover body 50 with a cap 52. The battery protective circuit as described above can be placed into the cavity of the cover body 50 and the cap 52 simply snaps into place and can be adhesively sealed. A cover lock 54 can be provided to lock the cap to the cover body 50. Note that there are many types of cover lock and only one type is illustrated here. In the cavity of the cover, there are notches 56 for supporting the battery protective circuit. Again, this combination of cap and cover body are injection molded as one piece and can greatly simplify the assembly process while keeping the manufacturing costs of the cap and cover body low.

While the present invention has been described with reference to certain preferred embodiments, it is to be understood that the present invention is not to be limited to such specific embodiments. Rather, it is the inventor's contention that the invention be understood and construed in its broadest meaning as reflected by the following claims.

Thus, these claims are to be understood as incorporating and not only the preferred embodiment described herein but all those other and further alterations and modifications as would be apparent to those of ordinary skilled in the art.

We claim:

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